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Chemothermal procedure and device for

Sterilization of mattresses and large volume

A new procedure for the chemo-thermal disinfection and sterilization of mattresses and large volume bed textiles concerns bed textiles the invention. The usual and increasing use of thermal-unstable materials with the production of mattresses and large volume bed textiles such as blankets, cushion etc. often the application of well-known disinfection and sterilization procedures, for example with hot-air, forbids steam, large quantities of aldehyde gas, aldehyde steam or ethylen oxide gas. Except the material incompatibility also the Bildung of toxic arrears disturbs in some cases.

It is well-known that chemical disinfection and sterilization means likewise increase and partly strengthen their effectiveness during rise in temperature. In practice therefore disinfection and sterilization are accomplished by treatment lasting several hours and partly even longer with the disinfection and sterilization means at increased temperature.

These chemo-thermal disinfection and sterilization procedures make a working at lower Tempera for doors possible than sow-ion-muddled with purely thermal disinfection and Sterili. Nevertheless relatively large Men towards chemicals and long induction periods of several are also with more combined at idiom of chemicals and temperature

Hours (z. T. Days) necessarily, in order one are sufficient to obtain the effect. Finally is already seeks to accomplish the purely thermal disinfection and Sterilisation by microwaves. Although individual authors want to have observed certain effects, which go out over the purely thermal effect of the microwaves, then the critical examination resulted in that

Microwaves for itself alone only in the measure are effective, like it for the heating up those which can be sterilized and/or. desin flierenden objects comes; see. Inhibition and Destruction OF the Microbial Cell, W. B. Hugo, Acad. Press London, new one York 1971, page 302 - 303.

From the US-PS 37 53 651 is well-known to sterilize sealed medical instruments in place of origin usual with heat by microwaves. Here however no special effect obtained in relation to the conventional sterilization of Kleingeräten.

Special problems exist with the frequently necessary, but expensive disinfection and sterilization bed textiles large volume of mattresses and in hospitals, sanatoriums as well as hotel, which will also frequently omit because of the substantial complications.

There was thus the task to develop a disinfection and a sterilization procedure which are as universally as possible applicable, with few chemicals gets along and beyond that already in short treatment times a sufficient disinfection and sterilization effectuation. This task could be solved now surprisingly by the fact that one actually admitted disinfection and sterilization means, preferably in more aqueous or aqueous alcoholic solution as well as microwaves uses.

The combination of these two measures leads to surprisingly good results concerning consumption at chemicals as well as extremely short treatment times. Further this combination permits the disinfection and sterilization of objects, which could be disinfected and/or sterilized so far only under largest expenditure, i.e. mattresses and large volume bed textiles, if they are made of foam material, rubber or plastic. In particular porous and cracked materials can be disinfected and sterilized in the procedure according to invention for the first time material-fairly, thoroughly and in addition fast. One obtains particularly good successes with interval-moderate treatment by microwaves, since thereby interval-moderately the disinfection and sterilization means evaporate and again settle and thus better still than gases or liquids in tears and pores penetrate. The interval-moderate treatment with microwaves permits further outstanding control of the temperatures with the objects which can be treated, so that also thermal-unstable materials can be disinfected and sterilized according to invention. For the execution of the procedure according to invention the objects with a solution of the disinfection and sterilization means, which can be treated, ground in-moistened and afterwards the microwaves suspended. Since the microwaves penetrate also non-metallic material, not only the outside, but also the internal surfaces and devices are purposefully reached. The steep temperature gradient during microwave heating of small damp tightnesses permits it to achieve in comparatively short time intervals of only few seconds the desired temperature optima. Ici interval-moderate working are able to preferably evaporate those infections and to sterilization means in aqueous or ASP-CSSR-Industrial union-alcoholic solution alternating and condense and also with difficulty attainable surfaces on the inside of po roses bodies to reach.

The high effectiveness of the combination of chemicals and microwaves leads to substantial savings at disinfection and sterilization means as well as energy. This leads not only to substantial reduction of costs, but also to a reduction of the environmental impact.

The execution of the procedure can take place in different way: 1. In a chamber below the brought in, to enteinkennende material a disinfectant reservoir is heated up with the help of the microwaves and brought to the evaporation. If necessary by ventilation these can Fog to be rolled over and thereby on that too itself germinating materials to strike down. In such a way moistened Materials can be exposed to the microwaves now and be disinfected in optimal way and siert sterili.

2. The disinfection and sterilization means are sprayed by a nozzle system on or into the objects, whereby this spraying procedure can happen forwards and/or during sending of microwaves.

3. The material can outside of the microwave chamber in most diverse way washa-smells by hand or through do towards to be moistened.

4. The humidification can if necessary, also interval-moderately by blow appropriate damp steams as well as by pressure and without temperature differences to be managed.

5. The germ-killing disinfectant solution can in at the pullen from through-jetable material filled into those Chamber to be brought in. By the rise in temperature the ampuls at being burst and to that Contents verpuffen. Are favourable also suitable Drucken Höffnungen applicable, so that these refillable at the pullen can be used several times one behind the other in the same way again. In particular with intervallmäs sigem employment so a simple dosage of Iri schem disinfection and sterilization means can erfol towards.

objects which can be treated are brought manually and/or automatically and removed again. In special if these parts additionally the metal contained, a too high it knows hitting by Energieabsorption of the metal parts avoided to become by interval-moderate treatment. The procedure is thus very flexibly applicable and can be adapted within wide limits to the verschiedene tasks.

With repeated application of the microwaves from stage to stage the temperature level of the aqueous preparation solutions and that will increase objects which can be treated. This temperature increase can be used in meaningful way to accelerate after the disinfection and sterilization a drying of the material and a removing of damp nebulae.

As disinfection and sterilization means many well-known solutions of active substances are suitable. Depending upon purpose and setting of tasks they are selected, in order to reach and/or over long periods germ growth and Rekontamination avoid either in short time intervals sterility or germ poverty or limit. Most of the well-known disinfectants close a application-justified compromise between their characteristics and tasks. By the controllable run erfindungsgegenstände procedure, in particular with interval-moderate application, are possible it to affect active substances with long-term and/or more urreizcharakter optimally. The procedure can be steered in particular in such a way that one remains always below 1000 °C, preferably in the range 50 to 800 °C.

Except that now the use of such substances is possible for well-known materials, which become antimicrobially effective only under the effect of the microwaves or effective component free to set. Likewise the employment of toxically precarious active substances is substantially facilitated or made possible by the possibility of the additive of inactivating reagents, and/or, by the microwave treatment split into not-toxic components.

As sterilization and/or. Disinfection solutions worked satisfactorily in particular aqueous and aqueous alcoholic solutions and emulsions or dispersions. If necessary, can also combinations of active substances be used as well as gewünschtenfalls textile preservative agents, Antikorrosiva and Tenside be caused. As additional components come for example except water and low aliphatic alcohols Diols and their esters, ether and ether ester, aromatic alcohols and their derivatives such as Phenylalkohol, benzyle alcohol, chlorine benzyle alcohol, phenolic active substances as arylate and alkylated phenol, Biquanide and its derivatives, 8-Hydroxichinolins and derivatives as well as quaternäre ammonium and Phosphoniumverbindungen infrage.

As halogeneous-splitting off connections know Hypochlorit, Chlorine amines, Chloriscyanursäuren, iodine and Jodophore to be used. Preservative acids, their salts and esters such as benzoic acid, Salizylsäure, Sorbinsäure, formic acid, aldehydic active substances, formaldehyde, Glyoxal, Glutaraldehyd, Succinaldehyd, circular connections with aldehydischen groups and groups of aldehydes splitting off substances such as half acetals and acetals can be used. Preferred can be also used: water-soluble inorganic peroxides such as H2O2, Ammoniumperoxodisulfat, Kaliumperoxodisulfat, Natriumperoxodisulfat, H2O2-Harnstoffaddukte und A., or organic peroxides with sufficient water solubility and/or under solution switching of water solubility which can be caused.

As particularly preferentially are considered such peroxides, which already show increased radical formation and decay by rise in temperature to 30 °C to 80 °C within minutes. The toxic characteristics of the developing residual substances determined agreement or refusal with the selection of the active substances.

Also possible such organic peroxides are to be selected, which beside their "by-oxidically" - caused spontaneous effect in form of its decay remains a preservative effect on the treated materials left.

Suitable substances are ecyll and Diacylperoxide, Peroxidcarbonate, alkyl or Diacylperverbindungen, Peracetale, Ketonperoxide, Persäuren und hydraulische peroxides. They are alone or on mixtures in aqueous dressings usable.

The reactive characteristics of the substances and groups mentioned can be modified by suitable activators, so that a control of response time and the activation temperature is reached and so that also a suitable inactivating phase can be brought into the sterilization procedure.

As source for microwaves commercial Mikrowellen-Generatoren can be used. It offers itself however to develop for the new procedure devices which are optimally adapted to the new intended purpose, since in particular the dimensions of the commercial devices for that are in accordance with-muddled not optimally selected invention, so that it comes to unnecessary dead volume and not optimal using of the microwave energy. For the application of the procedure according to invention for large objects such as mattresses etc.

offers itself to develop on these dimensions out major items of equipment.

A preferential execution form of a device for the execution of the procedure for the chemo+thermal disinfection and sterilization from mattresses and large volume bed textiles is in Fig. 1 represented and consists of a preferably mobile container 1 with a lockable Einlassschlitz 2, a lockable exhaust port 3, a drum 4, 4 A of an inlet flap 5, a discharge opening flap 6, a central stored, if necessary actively swivelling employment 7 with at least one microwave transmitter 8, a liquid tank 9 and associated spray nozzles 10 and 10'.

In order to facilitate introduction and a taking of the material out, a propelled roll of 11 A and feed roll 12 and if necessary before the exhaust port 3 a further propelled roll of 11 A and feed roll 12 A are present behind the Einlassschlitz 2.

Further the drum 4 is designed as role wall and shields the microwave radiation before the withdrawal from the chamber. The internal drum wall 4 A is from a microwave-permeable material, z. B. Plastic and is propelled by the engine 13, whereby the material is transported actively.

Before the inlet and exhaust ports 2 and 3 can be attached gewünschtenfalls opening by hinges doors and supporting tables, which facilitate the handling.

The execution of the procedure according to invention the materials which can be treated become such as mattresses etc. inserted into the drum 4, 4 A, whereby they are moistened by means of the spray nozzles 10 and 10'. Afterwards the Einlassschlitz 2 and the inlet flap 5 and it close switch themselves that and/or, the microwave transmitters 8 and the engine 13.

After completion of the treatment the engine and the transmitter are switched off and the exhaust port 3 as well as the discharge opening flap 6 are opened and the material is taken. Because inlet and discharge opening are spatially from each other separate, comes it generally to no Reinfektion of the material already treated.

As microwaves in principle all appropriate warm-producing waves infrage come, however only certain frequencies for the heat production with microwaves become certified in most countries. Into countries and areas, where such restrictions do not exist, thus also devices with broad wave spectrum can be used.

The procedure according to invention is more near described in the following examples, whereby from the comparison attempts those come out surprisingly good effectiveness.

Example 1 as test objects of the sterilization of metal parts for example the Federkernen in mattresses etc. high-grade steel screws were inoculated garden earth suspended by 25 mm of length and 5 mm in diameter fine thread on 0,1 ml.

The garden earth contained and, A. approx. 103 to 104 Klebsiella spec. - Germs and approx. 106 to 107 Bac. subt. spec. Sporen.

The screws were put on filter paper and covered with filter paper. Directly before the microwave treatment 0.1 ml active substance solution was up-dripped on the filter paper. The active substance solution consisted of aqueous alcohol in concentration from 0 to 30%. The induction

period of the microwaves in seconds was varied from 30 to 150 seconds, whereby commercial microwave equipment was used with 1100 W power output (privilege, Hitachi, distributing house source). The screws were unrolled afterwards on agar plates and examined on germ growth. The evaluation of the results took place after the following key: xxxx: massif growth, lawn xxx: loose lawn xx: approx. 50 colonies under the edition x: approx. 10 colonies 0: no colony formation The results are arranged in the following table 1:

Table 1
EMI 11.1

```
<tb> alcohol
<tb> <September> \ <September> 9
<tb> <September> 0
<tb> Time \
<tb> in <September> egg <September> 0 <September> 5 <September> 10 <September> 20 <September> 30
<tb> <September> 30 <September> xxxx <September> xxxx <September> xxxx <September> xxxx <September> xxxx
<tb> September <traces> 15 <September> xxxx <September> xxxx <September> xxxx <September> xxx <September> xxx
<tb> <September> + <September> 60
<tb> September <traces> 15 <September> xxxx <September> xxxx <September> xxxx <September> xxx <September> xx
<tb> <September> + <September> 90
<tb> September <traces> 15 <September> xxxx <September> xxx <September> xxx <September> xx <September> x
<tb> + <September> 120
<tb> Control <of September> = <September> 60 <September> Alcohol <September> xxxx
<tb> As a check screws with 60%igem alcohol became 1 hr.
```

without microwave effect treats. Here still isolated education Gramnegativer bacteria colonies and *Bazillus subtilis* cultures showed up in great quantities.

The table shows clearly that neither the alcohol with one another, still the microwaves can alone or in combination in a the position be attained the disinfection and sterilization.

Example 2 linen small cloths contaminated with A) Sporenerde (106 Sporen per g) b) of an excrement suspension with *E.Coli*, *Enterokokken*, *Prot*.

vulg., *Pseud. aerug.*, *staphylococci*, *Candidahefen* etc.

10 - 108 germs and 10 Sporen of the Bac. Subt. Type ml.

These rags became in each case 2 min. a microwave treatment in accordance with example 1 suspended, whereby as chemicals el202, formaldehyde, Glutaraldehyd and p-chlorine-m-cresol were used. The Abtötungskonzentration was determined - tion the active substances. The results are arranged in nachtol genes the table 2. The results show that in comparatively very low concentrations and very short induction periods of the microwaves already outstanding results are obtained.

Table 2

Mixture vegeta tiver germs Sporenerde (excrement (1: 4) Suspension* Bac. subt.

H2O2 0.3 - 1.2% 0.6% formaldehyde 0.2 - 0.5% 0.8 - 1.6% Glutardi 0.5% 0.5 - 1.0 W aldehyde P-chlorine-m 0.5 - 1.5% > 5% cresol determination of the biociden/sporiciden concentrations with 2-minütiger microwave effect *ohne consideration of continuous forms.

Example 3 in similar way as in example 2 pieces of rubber hose were described as germ carriers with Bac. subt. Sporen infects and a microwave heating suspended. The germ number proof in the subculture resulted in that the Keimzahl of 106 had sunk after 30 seconds already on 103, after 60 seconds on 102 and after 90 seconds on 0, thus sterility was obtained.

Example 4 particularly problematic is the disinfection and sterilization of mattresses. In order to simulate conditions into mattresses, central in prepared bags of a mattress foam material block brought becoming germ carrier (linen small cloth). The foam material block had the size of 20 x 20 x 10 cm and with in each case 120 g of a H2O2-Lösung was before soaked. This quantity was stopped by squeezing the redundant volume off. The germ-killing effect H2O2-Lösung as a function of concentration and time, stabilized of, comes out from the following tables 3 and 4. Table 3 shows the results with the excrement suspension in accordance with example 2 1Tabelle 4 the results with Bac. subt. Sporen into Gärtenerde. Die germ number A SEED in table 3 amounted to 108 germinates, with the garden earth 5 x 106 Sporen. Control of germ growth was accomplished on agar plates with disinhibiting means for the neutralization of active substance remainders, after 24, 48 and 72 hours with 37 C. The evaluation of germ growth took place after the key in accordance with example 1. The Temperatur dcs foam material block was kept constant by controlling of the microwaves between 60 and 65 C.

Table 3
EMI 13.1

```
<September> Time
<tb> <September> Min.
<tb>
```

```
Konzentr.
<tb>
```

```
II202 <September> in <September> \ <September> 1 <September> 2 <September> 3 <September> 4 <September> 5 <September>
Control
```

```
<tb> II202 <SEPTEMBER> in
<tb> <September> 3.5 <September> xxxx <September> xxx <September> xxx <September> xx <September> x <September> xxxx
<tb> <September> 7.0 <September> xxxx <September> xxx <September> xx <September> x <September> 0 <September> xxxx
<tb> <September> 1 <September> 0, <September> 5 <September> xxx <September> xx <September> x <September> 0
<SEPTEMBER> 0 <September> xxxx
<tb> <September> 14.0 <September> x <September> 0 <SEPTEMBER> 0 <September> 0 <September> 0 <September> xxxx
<tb> <September> 1 <September> 7, <September> 5 <September> 0 <September> 0 <September> 0 <September> 0 <September> 0
<September> xxxx
<tb> Short time sterilization of excrement (germ carrier attempts) Table 4
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EMI 14.1

```
<tb> <September> Time
<tb> Min.
<tb>
```

```
Kc
<tb> zenith;
```

<tb> 11.02 <September> in <September> \ <September> 1 <September> 2 <September> 3 <September> 4 <September> 5
 <September> Control
 <tb> fli (j) / ml
 <tb> <September> 1.75 <September> xxx <September> xxx <September> x <September> x <September> 0 <September> xxxx
 <tb> <September> 3.5 <September> x <September> 0 <SEPTEMBER> 0 <September> 0 <September> 0 <September> xxxx
 <tb> <September> 7.0 <September> 0 <September> 0 <September> 0 <September> 0 <September> 0 <September> xxxx
 <tb> <September> 10.5 <September> 0 <September> 0 <September> 0 <September> 0 <September> 0 <September> xxxx
 <tb> <September> 14.0 <September> 0 <September> 0 <September> 0 <September> 0 <September> 0 <September> xxxx
 <tb> Short time sterilization of Sporenerde (germ carrier attempts)

Example 5

For the attempt after suitable model was made to the size a feather/spring core mattress. Its mass were 30 x 30 x 15 cm.

The pad situations consisted of

1. Purchase (heavy Matratzendrell)
2. Purchase under 1. (easy Drillware)
3. Polsterwatte, quilted (8 to 10 mm strongly)
4. Sea-grass filling (10 to 15 mm strongly)
5. Bag linen on which the sea-grass filling was attached
6. A metal frame rack of 25 x 25 x 12 cm extent places on the original feather/spring core to the admission of the noble steal-screws (S. Example 1). The Edelstahlschrauben serves as with difficulty disinfected germ carriers.

As textile germ carriers linen small cloths (example compared 2 and 4) were placed between the individual pad situations, so that for the evaluation three germ carrier samples taken at the same time were available. Before placing the contaminated germ carriers the model "feather/spring core mattress became with the help of a two-material nozzle border /Luft (3.0 to 3.5 bar), active substance solution (pressure los) outside of the treatment chamber evenly through moistens. The composition of the active substance solution was combination of H₂O₂ thieves nzoyleperoxid, methylethylketone peroxide in 10 pastes an isopropanol solution with an available oxygen content of 12 mg/ml. The moisture absorption of textiles and pad situations amounted to 40 + 5 ml. The weight of the Folsterung amounted to 420 g, the total volume of the model 13.5 l.

With was accomplished in intervals of the microwave irradiation and tracing 30 seconds each with a total time by 1 x = 1 minute to 8 x = 8 minutes. Three germ carriers were inferred parallel and are considered as a sample. The evaluation took place via recultivation of the remainder germs on A) agar plates and b) via culture in nutritive solution without valuation of the remainder germ density became germ growth through "+" and missing growth (sterile findings seized by 0 in the table.

The results are arranged in the following table 5.

Table 5 treatment interval attempt with excrement suspension of attempts with Sporenerde amount of and treatment agar culture nutritive solution agar culture nutritive solution remarks total period duration culture culture 0 0 +/+ + +/+ + +/+ +/+ control of n. 48 hr. Bebrütungszeit with 37 C.M. - W. Entirely in seconds of 1 x = 1 min. 30 60 +/0 + +/+ + +/+ +/0 + n. 48 to 72 hr.

2 60 120 +/0/0 +/+ 0/0/0 +/+ 0 n. 72 hr.

4,120,240 0/0/0 0/0/0 0/0/0 0/0/0 0/0/0 0/0/0 n. 7 days 8,240,480 0/0/0 0/0/0 0/0/0 0/0/0 0/0/0 n. 7 days